In Dr. Pole's typical case of dichromic vision, the sensation which is absent is the middle one, and the two existing sensations are not both identical with those in normal eyes, but have their maximum impressions produced by vibrations whose rates are nearer together, so as not to leave the retina insensible to the middle of the spectrum. His long-wave colour corresponds with the sodium line D, which is therefore a primary to him, and his short-wave primary is probably violet; green light, accordingly, causes very little sensation, or will appear yellowish or bluish, as its vibrations come within the scope of one or other of the two existing sets of nerves.

It appears to me, *à priori*, that it is not unlikely, in the case of the absence of the intermediate (green) sensation, that the other two sensations should become approximated, so as to be of more use in discriminating a continuous series of colours; and such an "equilibration" is analogous to the hyper-sensitiveness of touch or hearing to which a blind man attains, one channel of communication with the external world the more readily lending its aid when another is closed.

This hypothesis of *individual differences in the primary colour-sensations* seems satisfactorily to remove the apparent violence done to the facts of dichromic vision by the Young-Helmholtz theory, and to accord with all other evidence of the physical basis of perception of colour. A. H.

Prof. Mivart on "Tails"

In the Davis lecture (NATURE, vol. xx. p. 509), Prof. St. George Mivart remarks that kangaroos use their tails "to a certain extent in their long jumps." This may either mean that the tail is used as a balance to the fore-part of the body—as, of course, is the case—or as a means of propulsion. The latter is the natural inference to be drawn from the sentence.

The belief that kangaroos thus actively employ their tails is of wide extent in Australia, but a residence there of over three years, principally in the bush, so thoroughly convinced me that the idea was erroneous that I think I am justified in challenging the Professor, if I have not misinterpreted him, to give the evidence on which his statement is based.

As we have recently learnt, through photographs of a galloping horse (*vide Field*, June 28, 1879), eye observations, where movements are rapid, are not entitled to much weight; but still, as I have seen many hundred kangaroos pass at full speed, and have observed them especially in reference to this question, some little dependence may be placed on my assertion that the action of one of these animals in full stride is incompatible with the use of its tail as a third hind leg.

In the descent of the kangaroo in each leap, the tail swings freely upwards to a curve, whose arc is at about right angles to the slope of the back, and during the rise of the succeeding leap it falls, and is then apparently impeded by muscular action. Were the tail actively employed, it would have to strike the ground almost at the same moment as do the feet, and the whole form of the animal would be altered. The tail would have to be brought down rapidly, like a riding whip, whilst the upward swing would be retarded.

From the forward slope of the body in long leaps and the fact that then, of the hind limbs, only the feet touch the ground, it is evident that the portion of the tail that alone could be employed as a propeller would be the posterior and weaker part.

Again, if we consider the speed of the kangaroo over the ground—say, 15 miles an hour, or $7\frac{1}{3}$ yards in a second—we find that only length of bones and mobility of joints of the hind legs permit the feet to rest on the same spot of ground for even a fraction of a second. With the tail it is otherwise; in the position it is carried by the animal it must travel over the surface for some two feet, though but pressed against the ground for a tenth of a second. I fear not even the callous under-surface of a kangaroo's tail would long stand such terrible attrition.

If further evidence is wanted, it is to be found in the tracks left by kangaroos, wallaby, &c., that have travelled quickly over sand, mud, &c. There is seldom to be seen the mark of a tail, and then only as a graze. The very tendons of the tail are an argument against its utility in leaping, for those on the upper side are twice as powerful as those on the under.

In conclusion let me say that it has been suggested to me that the remark about kangaroos making use of their tails to carry grass might lead to the supposition that their tails are prehensile.

E. H. PRINGLE

Beckenham, September 29

In Prof. Mivart's interesting lecture on "Tails" the statement occurs that kangaroos "make use of their tails to a certain extent in their long jumps." This I believe to be an entire misapprehension. No doubt the massive tail of a kangaroo suggests the possibility of such use, and the idea is helped out by the very obvious employment of its tail by the animal in almost all its slow movements, when it rests of necessity on the ground. In leaping, however, the body is thrown forward at an angle which raises the tail from the earth. On the great sandy flats about the shores of Moreton Bay, kangaroos have often afforded me the opportunity of convincing myself that the tail touches the earth only occasionally and very lightly, probably when the balance of the body is not perfectly maintained. I have traced the marks of the great hind toes over this sand when damped by rain, and in the best condition to take the slightest impression, and have never found anything more than a *very faint* mark now and then, and that evidently such as had not been produced by any effort of the animal to urge itself onward by means of its tail. In one instance the track of a kangaroo, which had crossed a flat within sight of me at full speed, happened to cut the track of some small wading bird, which enabled me to compare the deep holes made by the powerful stroke of the hind legs with the shallow oval mark made by the tail, about half a dozen times only in a distance of about four hundred yards, and the track of the bird. Had any propulsive force been used, this mark must have been very distinct on a surface capable of taking a perfect impression of the bird's foot. The rock kangaroos leap in exactly the same manner as their larger congeners, yet their long and comparatively slender tails could hardly be supposed by any one to render them any assistance. Even in the confined space allotted to them in the Zoological Gardens it may be seen that kangaroos leap without any help from their tails, and when they are going very fast the axis of the body is thrown forward into a position approaching the horizontal, and the tail is then quite clear of the ground. Prof. Mivart is not singular in his misapprehension on this point, for I find in Prof. Alleyne Nicholson's "Manual of Zoology," edition 1875, p. 580, that "the tail is also extremely long and strong, and by the assistance of this organ and the powerful hind limbs, the kangaroos are enabled to effect extraordinarily long and continuous leaps."

ARTHUR NICOLS

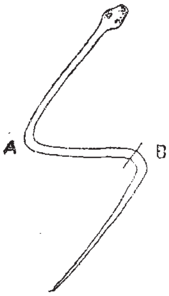
About Snakes

How do snakes progress? I ask this question in full knowledge of all that has been written on the subject, and nought that I have read satisfies my mind nor meets all requirements. The books tell us that the ribs of the snake are its legs. All well and good, as long as we are dealing with smooth plane surfaces and sluggishly moving snakes, as the boas; but the theory utterly fails with snakes which literally fly through grass, or climb trees or walls with equal facility. On one occasion I allowed a boa to pass over my hand pressed flat on the ground, and I distinctly felt the onward movement of the rib legs, acting exactly like the outside legs of the centipede, and I felt quite satisfied that, under the circumstances, the snake was moving by means of its ribs.

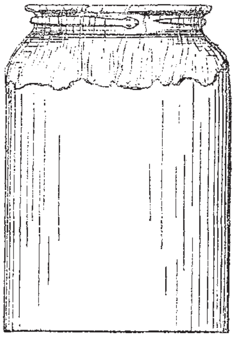
But this timid and harmless rat snake, which you see absolutely flying through the grass to escape you, cannot be moving by the aid of its ribs; for first, there is nothing for them to act on, and secondly, you cannot imagine the ribs acting rapidly enough to ensure the immense speed at which the animal passes through the high grass. Look at this tree snake surveying you from a bough; how did it get there? The books will tell you, by winding itself round the tree, and thus progressing upwards; but a slender snake of 12—18 inches in length cannot grasp a trunk 2 feet in diameter for the first start up the tree, and so it must get up some other way.

How did this little snake 9 inches long ascend the side of a glass jar 10 inches high, and assume the position I shall presently describe? Certainly its rib legs gave it no assistance.

The man who brought the boa, had with him an earthen pot full of small ash-coloured snakes, quite new to me, and I never saw ferocity and activity more remarkably combined than in those small reptiles; on taking them out by the handful, they fastened their jaws (well armed with teeth) upon the man's hand and wrist, and hung like gigantic leeches. Accustomed to such attacks, the snake owner removed the little demons, each separately, with some difficulty, and the wounds bled freely. But the activity, and mode of progression in these snakes interested me more than their ferocity; thrown on the ground they immediately assumed this figure, and then began to fly about in all directions, requiring some trouble and agility in re-collecting them. I analysed their progression carefully, and found it to be both progressive and retrograde, the former predominating. The body at B seemed to become rigid for a second, allowing the upper part A to be thrown, not *crawled*, forward, and thus for a second the animal was straight; then A, with a slight retrogression, became rigid, and B advancing, the animal assumed the shape shown. It advanced with astonishing rapidity by a series of jerky undulations. In fact, making full allowance for friction, the snake swam on land, and its rib legs were of no use whatever to it in progression.



Now let me say a few words about the small snake in the glass jar, and I shall then be in a position to advance my ideas about anguine locomotion. As before mentioned, I placed the little creature (a harmless one) in a large glass jar ten inches high, and stretching a bit of coarse muslin over its broad mouth, secured it by an elastic band. A day or two after, I was much surprised to find my snake gone, and more so to find the muslin band and elastic ring intact. No one had touched the jar, for a wholesome dread of snakes existed in the house, but yet the little animal had disappeared. On closer examination I discovered it *coiled outside the neck of the jar below its lip, and between the muslin and the glass*, thus—



How did it get there?

Deeply interested, I replaced the snake in the jar, and carefully watched its attempts to resume its strange position. I found it had no difficulty in ascending the side of the jar and standing erect on its tail, and its movement in doing so was graceful, unconstrained, and directly upwards. Watching more closely, *I saw the snake distinctly adhering to the glass*, its abdominal scales creating a vacuum exactly like the pedal scales of the common house-lizard. *There was not a doubt of it*, and I felt quite satisfied as to how snakes get into the strange localities in which they are found out here, and which I shall presently describe.

In many native huts you find cupboards extemporised by building round earthen pots, called gharrahs, into the mud walls, their mouths being flush with the smooth plastered walls, and about four feet from the ground, and one from the slope of the thatched or tiled roof. Cobras often are found coiled up in these pots, and the first intimation is the fatal strike at the hand of any one rummaging in the pots. How did the snake get there? "Off the roof to be sure;" but how did it get on to the roof of an isolated hut with smooth mud walls? How did the deadly kerarts get up into my bookshelves, where I have often found them coiled up on my books. Of the deadly snakes, this is the only one of a literary turn, and it is frequently found among books, a rather dangerous haunt for those who frequently refer to them. How did the cobra get into the double roof of my brougham, and frighten my wife out of her wits by wishing to share its interior with her? How did another get into the sleeve of my wife's dress, which was hanging two feet from the ground, on a wall peg?

I believe terrestrial snakes move in one or other of the following ways:—

1. On smooth plane surfaces, by means of their rib legs; *e.g.* the boa.

2. Through high grass, by a rapid, almost invisible, sinuous onward movement, as the hydrophidæ in water; *e.g.* the rat snake.

3. Climbing trees, or ascending smooth surfaces by erecting their abdominal scales (for climbing) or using them to produce a vacuum, as lizards do their foot scales for ascending smooth surfaces, *e.g.* tree snakes and cobras in native cupboards.

Deglutition in Snakes.—Soon after the capture of my little snake of the glass jar, I presented it with a frog, and watched proceedings. And here let me note that the snake was 9 inches long, with a delicate little head not $\frac{1}{2}$ an inch broad, while froggy was 2 inches long and 1 broad. Bearing in mind the old puzzle, "What's smaller than a mite's mouth?" "That which goes into it"—I watched proceedings with great interest, and was well rewarded, for the snake immediately seized froggy by the nose, the animal making desperate attempts with fore and hind-legs to shake it off, but all in vain. All this while the process of deglutition (?) was going on remorselessly, or rather, the snake was slowly but surely getting outside the frog, and in this fashion: by a sort of vermicular process you could see the sharp little teeth advance a little, and then the whole body wriggle up to the new hold on froggy's head. And so it very gradually disappeared; then came the shoulders, and the arms followed, pressed against the sides. When the teeth reached the sacrum the legs were violently convulsed, then they disappeared, and last of all the toes, and the snake was fairly outside froggy. Overjoyed, he rubbed his lips against the sides of the jar, gave two yawns, and then composed himself to digest. The whole process lasted exactly half an hour.

Snake Charmers.—I had not been many years in India when I had an excellent opportunity of seeing the so-called snake-charming, and of satisfying myself that it was only clever *legerdemain*. A couple of snake-charmers appeared in the compound and offered to purge it of all the snakes it contained. I embraced the opportunity with great alacrity, but insisted on dictating my own terms, which, after some demur, were agreed to. I selected one man (the other remaining with the baskets), and offered him the choice of accompanying me, either in his dhotee[1] only, and a bare head; or with his pugree[2] and a langootee.[3] He chose the latter costume, soon made his toilet, and stood before me all but naked. I satisfied myself that the langootee could not possibly conceal a snake, and I had yet to find whence the reptile could, or would be produced. So we proceeded to business, accompanied by a crowd of gaping servants. I led the way to a great prostrate trunk, beneath which a cobra (imaginary) was said to lodge, and here he started his rude bagpipe, and began his incantations and gesticulations. But the snake refused to be charmed, for the very good reason that it was not there, and the charmer could not evade my searching gaze. He now took the lead, and drew up before a tempting looking hole in a bank, where he felt sure he could seduce a snake. "Very well," said I, and we formed a semicircle, in the middle of which he stood, and resumed his incantations. Suddenly, to divert my gaze, he pointed to the hole, and exclaimed, "Dekho, sahib!" (look, master), and in a moment, extracted (apparently) a cobra from it. But he did not see that, in that moment I had observed his hand, like a lightning flash, extract a snake from the folds of his pugree, and simultaneously appear to extract it from the hole. The *modus operandi* was clever *legerdemain*, but unmistakable cheating. One of my servants saw the trick too, and was about to exclaim, but I silenced him with a gesture, and appeared convinced at the marvel. "Now," said I, "as you have found the snake, you must prove to me that it is poisonous," and so a poor chicken was sent for, and placed under a coop with the snake, but here again the snake-charmer overdid his performance, for dislocating the chicken's neck with his finger and thumb as he placed it under the coop, he immediately raised it, and exhibited the poor animal dead. If it had been struck by the snake, 10-15 minutes would have elapsed before death. I still seemed convinced, and on his coolly asking for the chicken for his dinner, I said I could not think of allowing him to eat a poisoned animal, and so ordered it to be buried.

---

[1] *Dhotee*, the voluminous waist-cloth worn by all Hindoos.

[2] *Pugree*, the cloth worn round the head.

[3] *Langootee*, a narrow strip of cloth worn between the thighs of the male, just sufficient to hide his nudity.

Having received their bakhsheesh, both men asked me for some brandy: as, at the moment, there was none in the house, and telling them so, one pointed to a large bottle of saturated tincture of ginger which was standing in the sun, and asked what it was. On my telling him, both asked for some, so I bade them sit down, and poured a mouthful down each gullet. The unexpected pungency of the shrub astonished them, but one of them, pressing his stomach with both hands, and with his eyes streaming with tears, gasped out "aur do" (more give). The other man said he had had enough. Both then rose, and shouldering their baskets, salaamed and left the compound.

Skin shedding among Snakes.—Though I have handled exuviæ by the hundred, and some of them just cast, I have never witnessed the process of skin-shedding, nor, I believe, has any observer.

It is well known that the skin is always found inverted, and very often, quite entire; and the general impression is that the snake fixes itself in a bush, or strong grass, and then wriggles out of its skin. But I have found the skin on the floor of a bath room, and on the rough ballast of a railway.

I believe that fixture is obtained by means of the abdominal scales, and that then the *modus operandi* is as follows: the skin ready to be cast, yields round the snake's mouth only, and remains adherent to the extremity of the tail. As the animal advances the caudal extremity of the skin is inverted, that is, pulled inwards, and so the process goes on, and is completed by the tail passing through the mouth of the skin; and thus the direction of the abandoned skin is directly opposite to the direction taken by the skin-casting snake. That is, if the mouth of the skin lies east, the snake went out to the west.

Take the finger of a glove, and pass a knotted thread inwards through its tip, then pull gently on it, and the tip of the glove will pass inwards and downwards, and ultimately pass through the base of the finger, which will now be uppermost.

Peshawar H. F. HUTCHINSON

(*To be continued.*)

A Plague of Rats

I HAVE read with great interest in NATURE, vol. xx. p. 65, a note of Mr. Orville A. Derby's on plagues of rats in Brazil. The same thing occurs sometimes in the south of Chile, Araucania, Valdivia, and Llanquihue, when the Coligue, and other species of the Bambuseæ have flourished and fructified, an occurrence which happens every 15-25 years. These grasses, with solid canes, unbranched, of sometimes more than 10 metres long and 8 cm. thick, flourish only once in their life, when they are 15-25 years old, and then their fruits ripen in astonishing quantity. This causes an enormous multiplication of rats and mice in the woods, animals rather rare commonly; and at the end of the same or the beginning of the next year, these animals have finished with their food, and are then obliged to migrate to the cultivated districts, where they are very noxious. The Indians collect the seeds of the Coligue as food, as the Brazilian natives seem to do with the fruit of the bamboo. I had occasion to observe this fact in 1869 or 1870, when I lived in Valdivia, and when almost all the Coligues of the province flourished at once and died afterwards; and I had heard it already before from the natives. FEDERICO PHILIPPI

Santiago, Chile, August 17

Solar Halo

ON Monday, September 22, about 12 o'clock, on the coast at Burnham, Somerset, my little boy called my attention to a large, clearly-defined, white circle, of which the zenith might be the centre; on the southern side of the circumference was the sun, above which were the arcs of two other circles, one of which was flattened. They united at a small distance above the sun, and displayed rather dull prismatic colours; between the points where these arcs joined the large white circle were two rather oval-shaped patches, also showing prismatic colours. The appearance lasted about an hour and a half. G. MAPLETON

Badgworth Rectory, Weston-super-Mare, September 23

CHEMICAL ACTION

WHY are the properties of bodies so profoundly modified by the action called chemical? Why do *certain* bodies *only* act chemically upon one another? What exact meaning is to be attached to the expression "chemical affinity?"

These questions, and questions such as these, have engaged the attention of chemists since chemistry began to be an exact science.

The products of chemical action are innumerable: chemical science is encumbered with a multitude of compounds, and each day additions are made to the number; but no general theory of chemical action has yet been broached which suffices to explain the known facts.

The consideration of the initial and final distribution of matter in a system upon which chemical action is exerted, has almost entirely engaged the attention of chemists, to the exclusion of the study of the course of chemical change, the conditions modifying this change, and the nature of the force which causes the change.

The molecular theory of matter furnishes us with a fairly complete answer to the question—Wherein consists the essential characteristic of chemical action?

Chemical action, says this theory, results in the production of new molecules, mechanical action results in changes in the rate of motion of existing molecules.

But why are new molecules formed only when certain bodies are brought into contact and not when other bodies are placed under similar conditions?

Because the first substances exert chemical affinity upon one another, whilst the others do not.

But what is chemical affinity?

The expression affinity was originally used to denote a resemblance between certain substances which exerted an action of some kind upon one another. But when the study of chemistry advanced, it was found that those bodies which most readily exerted mutual chemical action, were, as a rule, unlike in their chemical habitudes.

The expression affinity was, however, retained to express the fact that one body exerted chemical action upon another. This affinity could not be measured in terms of any unit, hence chemists were content to draw up tables of relative affinities. These tables were for the most part based upon qualitative reactions, and supplied merely empirical information.

In the year 1780 Bergmann formulated a general theory of chemical affinity: the main points insisted upon by Bergmann were, that the affinity between two bodies is independent of the masses of the bodies brought into mutual contact, and that the value of this affinity is constant under similar conditions. Bergmann further supposed that the relative affinity values of various substances may be empirically represented by the amounts of these bodies which mutually combine together: thus in the formation of a series of normal salts, the affinity of the acid is greatest according to Bergmann, for that base, the greatest amount of which is taken up by the acid. Conversely a base has the greatest affinity for that acid which combines with it in greatest quantity.

The latter part of Bergmann's theory could no longer be upheld when the atomic theory of Dalton had introduced clearer views concerning the quantitative action of chemical substances upon one another. But the atomic theory was not opposed to the view that the affinity between the bodies is independent of the masses of the bodies brought into mutual contact.

In the year 1803 Berthollet published his theory of chemical affinity, a theory which was essentially opposed to that of Bergmann. The French chemist said that the chemical action of one substance upon another is proportional to the mass of the acting body and to its affinity for the second substance. Berthollet thus considered not only the affinity of one body for another, but also the masses